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13. ABSTRACT (*Maximum 200 Words*)

The requested equipment would fill a tremendous void in Duke's capabilities, namely the ability to generate wavelength tunable sub-picosecond pulses in the UV-visible-IR spectral region. The required tools include a regenerative amplifier (RA) and pump laser, a frequency doubled and quadrupled optical parametric amplifier (OPA), and a difference frequency mixer to allow us to cover the entire spectral region from 200 nm to 15 microns. The pre-existing mode-locked Ti:S laser is used to pump the RA which in turn drives the OPA.

The proposal was to develop this capability for wavelength tunable, sub-picosecond optical characterization of the important optoelectronic wide bandgap III-N materials and heterostructures. With the grant, a Quantronix Titan regenerative amplifier, drivenbya Quantronix 527 DPH Nd:YLF laser was purchased. A Light Conversion TOPAS optical parametric amplifier was also purchased. The TOPAS can be frequency doubled, quadrupled, and mixed to allow continuous coverage of the spectral region 200 nm to 15 microns, encompassing most AlGaN and all InGaN-based materials.

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Final Report
AFOSR DURIP Grant

Wavelength-Tunable, Sub-picosecond Pulsed Laser Diagnostic Tool for III-Nitride Semiconductors

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Prof. H. Craig Casey, Dept. of Electrical Engineering, Duke Univ.
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Duke University has an expanding research effort in III-V nitrides with three faculty (Prof. H. Craig Casey, ECE; Prof. Stephen Teitsworth, Physics; Dr. Henry Everitt, Physics & Army Research Office) currently involved in various projects. Two laboratories have been recently converted to III-N work, one focusing on electrical characterization and one focusing on optical characterization. Notable facilities include :

- a pulsed femtosecond frequency doubled and tripled Ti:Sapphire laser system,
- CW HeCd photoluminescence (PL) system,
- Xe Lamp photoluminescence excitation (PLE) system,
- high-power pulsed current-voltage (IV) system,
- radio frequency (RF) and microwave sources and detectors, and
- access to high-power tunable pulsed infrared (IR) and ultraviolet (UV) light at the Duke Free Electron Laser Laboratory (DFELL).

The requested equipment would fill a tremendous void in Duke's capabilities, namely the ability to generate wavelength tunable sub-picosecond pulses in the UV-visible-IR spectral region. The required tools include a regenerative amplifer (RA) and pump laser, a frequency doubled and quadrupled optical parametric amplifier (OPA), and a difference frequency mixer to allow us to cover the entire spectral region from 200 nm to 15 microns. The pre-existing mode-locked Ti:S laser is used to pump the RA which in turn drives the OPA as seen in Figure 1.

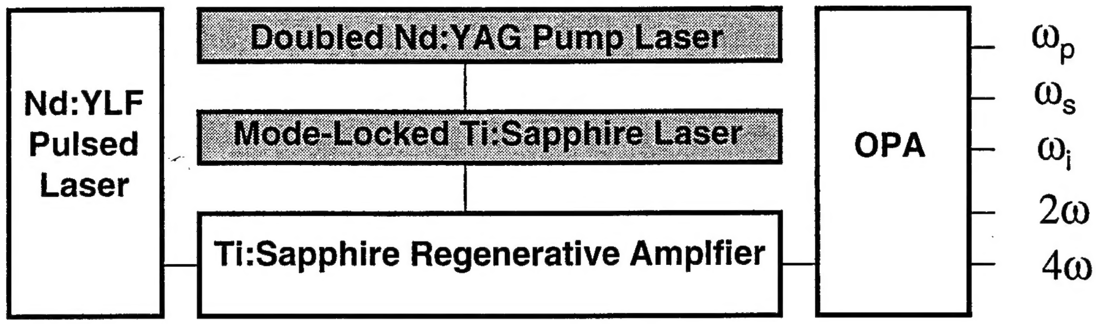

Figure 1. Diagram of requested equipment. Pre-existing equipment is shaded in gray.

We proposed to develop this capability for wavelength tunable, sub-picosecond optical characterization of the important optoelectronic wide bandgap III-N materials and heterostructures. With the AFOSR DURIP grant, we purchased a Quantronix Titan regenerative amplifier, driven by a Quantronix 527 DPH Nd:YLF laser (Figure 2). We also purchased a Light Conversion TOPAS optical parameteric amplifier. The TOPAS can be frequency doubled, quadrupled, and mixed to allow continuous coverage of the spectral region 200 nm to 15 microns, encompassing most AlGaN and all InGaN-based materials.

Originally, a Spectra Physics system was contemplated. However, Quantronix offered a superior capability (2 mJ per pulse vs. 1 mJ per pulse for Spectra Physics) and an acknolwedged superior optical parametric amplifier for a lower price. The Quantronix / Light Conversion system was purchased in the spring of 2001 and installed in the summer of 2001. We have spent the remainder of the summer reconfiguring our laboratory to accommodate the new system, including two repairs that have had to be made since installation. Once fully operational, this laser system will provide a unique capability to investigate the ultrafast, microscopic dynamics and fundamental parameters of one of the most important classes of optoelectronic materials.

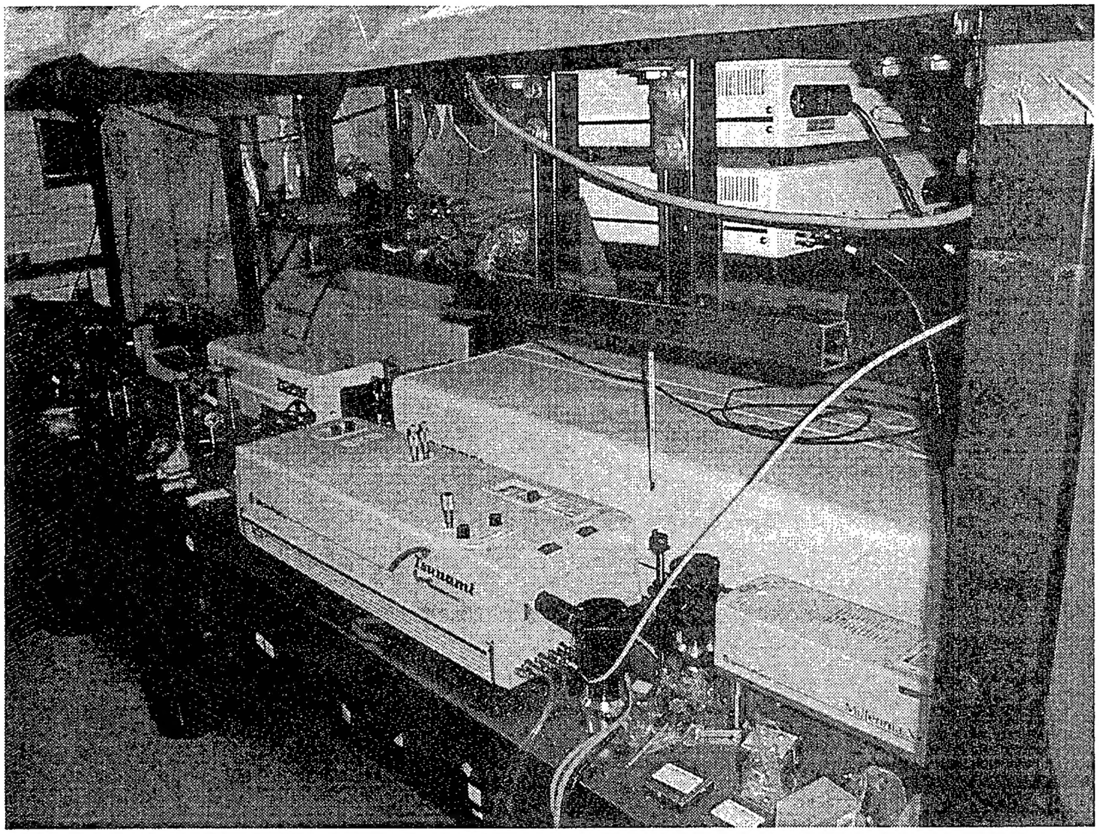

Figure 2. Installed laser system, including Quantronix Nd:YLF and Titan (background) and Light Conversion TOPAS (middle left).